CERTIFICATION

I, David Andrews, of 1-29 Akima-Minorigaoka, Annaka-shi, Gunma, 379-0109 Japan, hereby certify that I am the translator of the accompanying certified official copy of the documents in respect of an application for a patent filed in Japan and of the official certificate attached thereto, and certify that the following is a true and correct translation to the best of my knowledge and belief.

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[TITLE OF THE INVENTION] HIGH VOLTAGE WIRE ROUTING STRUCTURE OF HYBRID VEHICLE

[CLAIMS]

[CLAIM 1]

A high voltage wire routing structure of a hybrid vehicle provided with an engine and an electric motor which serve as driving sources for running, the engine being mounted in an engine room and a transmission which incorporates the electric motor being disposed adjacent to the engine, characterised in that a high voltage wire which connects an inverter disposed in the engine room and the electric motor is routed behind the engine with respect to a vehicle longitudinal direction.

[CLAIM 2]

The high voltage wire routing structure of a hybrid vehicle according to claim 1, wherein the high voltage wire is secured, at a middle portion thereof, to a securing body.

[CLAIM 3]

The high voltage wire routing structure of a hybrid vehicle according to claim 2, wherein the securing body comprises at least one of the engine, an engine accessory fixed to the engine, the transmission, and a transmission accessory fixed to the transmission.

[CLAIM 4]

The high voltage wire routing structure of a hybrid vehicle according to claim 3, wherein the engine accessory is an intake pipe that introduces air to the engine.

[CLAIM 5]

The high voltage wire routing structure of a hybrid vehicle according to any one of claims 2 to 4, wherein the inverter is fixed to a vehicle body and the high voltage wire includes a restricted portion which is secured to the securing body whereby movement is restricted, and a non-restricted portion which is not secured to the securing body so that movement is not restricted.

[CLAIM 6]

The high voltage wire routing structure of a hybrid vehicle according to claim 5, wherein the high voltage wire is routed such that the restricted portion is

positioned to the engine and the transmission side, and the non-restricted portion is positioned to the inverter side.

[CLAIM 7]

The high voltage wire routing structure of a hybrid vehicle according to any one of claims 3 to 6, wherein the transmission is disposed in back of the engine with respect to the vehicle longitudinal direction, the inverter is disposed above and near the engine, and the electric motor is connected to the high voltage wire at an upper portion of the transmission.

[CLAIM 8]

The high voltage wire routing structure of a hybrid vehicle according to any one of claims 2 to 7, wherein the high voltage wire is secured to the securing body at a point away from an exhaust pipe of the engine.

[CLAIM 9]

The high voltage wire routing structure of a hybrid vehicle according to claim 8, wherein the exhaust pipe is disposed to a vehicle lateral side when viewed from the engine.

[CLAIM 10]

The high voltage wire routing structure of a hybrid vehicle according to claim 9, wherein the engine is a V-type engine that has a pair of banks in which a plurality of cylinders are arranged in a vehicle longitudinal direction and an exhaust pipe is disposed to the vehicle lateral side of each bank, and the high voltage wire is routed above and near the transmission.

[CLAIM 11]

The high voltage wire routing structure of a hybrid vehicle according to any one of claims 2 to 10, wherein the inverter and the electric motor are connected by a plurality of high voltage wires, and the respective high voltage wires are secured to the securing body in a bundled state.

[CLAIM 12]

The high voltage wire routing structure of a hybrid vehicle according to any one of claims 2 to 11, wherein securing means for securing the high voltage wire to the securing body is provided integrally with the securing body.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[TECHNICAL FIELD]

The invention relates to a wire routing structure of a high voltage wire which connects an inverter and an electric motor incorporated in a transmission in a hybrid vehicle.

[0002]

[RELATED ART]

In recent years, a hybrid vehicle provided with two types of driving sources for running, namely, an engine and an electric motor, which have different characteristics, has been developed and is in practical use. In this type of hybrid vehicle, driving force of the aforementioned two types of driving sources are optimally combined according to conditions, thereby making full use of the advantages of each driving source while compensating for the disadvantages thereof. Accordingly, dynamic performance of the hybrid vehicle can be sufficiently ensured, while fuel efficiency and emission performance can be significantly improved. One such hybrid vehicle is that disclosed in patent reference 1, for example, in which a transmission is disposed in back of an engine with respect to a vehicle longitudinal direction, and an electric motor, power input-output means, and an electric motor are arranged in this order within the transmission.

[0003] In addition to the aforementioned patent reference 1, patent reference 2 is also given as a prior art reference relating to the invention.

[0004] [Patent Reference 1]

Japanese Patent Application Laid-Open Publication No. 10-58990

[Patent Reference 2]

Japanese Patent Application Laid-Open Publication No. 2000-152470

[0005]

[PROBLEM TO BE SOLVED BY THE INVENTION]

In the hybrid vehicle mentioned above, a battery and an inverter, and the inverter and an electric motor are connected by a high voltage wire, respectively. Direct current from the battery is converted into alternating current by the inverter to be supplied to the electric motor, and alternating current generated by the electric motor is converted into direct current by the inverter to charge the battery. The high voltage wire is required not to break or become disconnected even if impact is applied to the hybrid vehicle.

[0006] However, although the aforementioned patent reference 1 discloses the arrangement of the devices such as the electric motor and the power input-output means, it does not describe a high voltage wire and routing thereof. Thus, effects on the high voltage wire when an impact is applied as mentioned above is not taken into account. As a result, the aforementioned requirements may not be satisfied depending on the manner of the high voltage wire routing.

[0007] The invention is made in consideration of the aforementioned circumstances, and it is an object thereof to provide a high voltage wire routing structure of a hybrid vehicle by which breakage or disconnection of a high voltage wire can be suppressed even if impact is applied to the hybrid vehicle.

[0008]

[MEANS FOR SOLVING THE PROBLEM]

Hereafter, means for achieving the above object and operation and effects thereof will be described.

According to the invention according to claim 1, a high voltage wire routing structure of a hybrid vehicle provided with an engine and an electric motor which serve as driving sources for running, the engine being mounted in an engine room and a transmission which incorporates the electric motor being disposed adjacent to the engine, is such that a high voltage wire which connects an inverter disposed in the engine room and the electric motor is routed behind the engine with respect to a vehicle longitudinal direction.

[0009] In this case, if impact is applied to the hybrid vehicle, devices, parts, and the like arranged around the engine are generally more susceptible to deformation or displacement than the engine. Accordingly, for instance, when an impact is applied to the hybrid vehicle from the front, the devices, parts, and the like arranged in front of the engine are deformed or displaced to the rear, thus reducing the clearance between them and the engine. Similarly, for example, when an impact is applied to the hybrid vehicle from the side, the devices, parts, and the like arranged to a side of the engine are deformed or displaced, thus reducing the clearance between them and the engine.

[0010] Consequently, if a high voltage wire is routed in front of the engine with respect to the vehicle longitudinal direction, when an impact is applied to the hybrid vehicle from the front, the high voltage wire is pinched between the engine and the devices, parts, and the like arranged in front of the high voltage wire.

Furthermore, if the high voltage wire is routed to a side of the engine, when impact is applied to the hybrid vehicle from the side, the high voltage wire is pinched between the engine and the devices, parts, and the like arranged to a side of the high voltage wire. Consequently, such pinching may cause the high voltage wire to break or disconnect.

[0011] In regard to this point, according to the invention according to claim 1 in which the high voltage wire is routed behind the engine with respect to the vehicle longitudinal direction, deformation or displacement does not easily occur at the engine even if the impact is applied to the hybrid vehicle from the front. Therefore, it is less likely that the high voltage wire will be pinched between the engine and the devices, parts, and the like arranged behind the high voltage wire. Similarly, the high voltage wire is less likely to be pinched between the engine and the devices, parts, and the like arranged to the side of the high voltage wire. Consequently, breakage or disconnection of the high voltage wire can be suppressed even if an impact is applied to the hybrid vehicle from the front or side.

[0012] According to the invention according to claim 2, in the invention according to claim 1, the high voltage wire is such that a middle portion thereof is secured to a securing body.

According to this structure, movement of the high voltage wire at the point where it is secured to the securing body and therearound is restricted, thus suppressing interference with other parts which is caused by vibrations of that portion.

[0013] According to the invention according to claim 3, in the invention according to claim 2, the securing body comprises at least one of the engine, an engine accessory fixed to the engine, the transmission, and a transmission accessory fixed to the transmission.

[0014] According to this structure, the engine and the transmission vibrate together. If the engine accessory is fixed to the engine, or if the transmission accessory is fixed to the transmission, these accessories vibrate together with the engine and the transmission. If the high voltage wire were to move with respect to the electric motor due to such vibration, a load would be applied to a connecting portion of the high voltage wire with the electric motor. Therefore, it is necessary to make the connecting portion robust so that it can withstand the load. As a result, the shape of the connecting portion or the connection structure may become complicated.

[0015] In this regard, according to the invention according to claim 3 in which the high voltage wire is secured to at least one of the engine, the engine accessory, the transmission, and the transmission accessory, movement of the high voltage wire with respect to the electric motor is suppressed, thereby reducing the load applied to the connecting portion of the high voltage wire with the electric motor. Consequently, the shape of the connecting portion of the high voltage wire or the connection structure can be simplified.

[0016] According to the invention according to claim 4, in the invention according to claim 3, the engine accessory is an intake pipe that introduces air to the engine.

According to this structure, a temperature of the intake pipe as the engine accessory is considered to be the lowest from among the engine, the engine accessories, the transmission, and the transmission accessories. Accordingly, by securing the high voltage wire to the intake pipe, it is possible to minimize the effect of heat on the high voltage wire from the engine, transmission, and the like.

[0017] According to the invention according to claim 5, in the invention according to any one of claims 2 to 4, the inverter is fixed to a vehicle body and the high voltage wire includes a restricted portion which is secured to the securing body whereby movement is restricted, and a non-restricted portion which is not secured to the securing body so that movement is not restricted.

[0018] According to this structure, the restricted portion of the high voltage wire is restricted from moving by being secured to the securing portion, and thus is less likely to interfere with other parts.

Meanwhile, movement of the engine and the transmission normally differ from that of the inverter fixed to the vehicle body. Therefore, the high voltage wire that connects the inverter and the electric motor must include a portion to absorb relative movement between the inverter and the engine, transmission, and the like. In regard to this point, according to the invention according to claim 5, the non-restricted portion functions as the absorbing portion described above. That is, when the engine and the transmission move with respect to the inverter, the non-restricted portion deforms in accordance with such movement. Then, the deformation of the non-restricted portion absorbs the relative movement mentioned above.

[0019] According to the invention according to claim 6, in the invention according to claim 5, the high voltage wire may be routed such that the restricted

portion is positioned to the engine and the transmission side, and the non-restricted portion is positioned to the inverter side.

[0020] In this case, the engine moves in a rotational direction, a longitudinal direction, or a vertical direction or the like in accordance with the operation thereof. In addition, the transmission vibrates in accordance with operation thereof. As a result, relative movement occurs between the engine and transmission, and the inverter which does not vibrate by itself. In this regard, according to the invention according to claim 6, the aforementioned relative movement can be absorbed due to deformation of the non-restricted portion of the high voltage wire that is positioned to the inverter side.

[0021] Moreover, the restricted portion of the high voltage wire that is positioned to the engine and transmission side is secured to the securing body. Thus, the restricted portion is less likely to interfere with other parts, and vibrates together with the engine and the transmission (including the electric motor). Consequently, application of a load on the electric motor caused by the relative movement of the high voltage wire with respect to the electric motor can be suppressed.

[0022] According to the invention according to claim 7, in the invention according to any one of claims 3 to 6, the transmission is disposed in back of the engine with respect to the vehicle longitudinal direction, the inverter is disposed above and near the engine, and the electric motor is connected to the high voltage wire at an upper portion of the transmission.

[0023] According to this structure, the inverter, the high voltage wire, and the connecting portion between the electric motor and the high voltage wire are positioned near and above the transmission disposed in back of the engine with respect to the vehicle longitudinal direction. As a result, the electric motor and the inverter can be connected by the high voltage wire by the shortest route or a route close thereto.

[0024] According to the invention according to claim 8, in the invention according to any one of claims 2 to 7, the high voltage wire is secured to the securing body at a point away from an exhaust pipe of the engine.

[0025] According to this structure, since the high voltage wire is distanced from the exhaust pipe, it is not susceptible to the effects of heat radiated from the exhaust pipe.

According to the invention according to claim 9, in the invention according to claim 8, the exhaust pipe is disposed to a vehicle lateral side when viewed from the engine.

[0026] According to this arrangement, the high voltage wire routed behind the engine with respect to the vehicle longitudinal direction is distanced from the exhaust pipe disposed to the vehicle lateral side when viewed from the engine. Consequently, as a result of this distance, the high voltage wire is not susceptible to the effects of heat from the exhaust pipe.

[0027] According to the invention according to claim 10, in the invention according to claim 9, the engine is a V-type engine which includes a pair of banks in which a plurality of cylinders are arranged in the vehicle longitudinal direction, respectively, and an exhaust pipe is arranged on the vehicle lateral side of each bank. The high voltage wire is routed near and above the transmission.

[0028] According to this structure, since the high voltage wire routed near and above the transmission is distanced from the exhaust pipes each of which is disposed to a vehicle lateral side of the banks of the V-type engine, it is not susceptible to the effects of heat radiated from the exhaust pipes.

[0029] According to the invention according to claim 11, in the invention according to any one of claims 2 to 10, the inverter and the electric motor are connected by a plurality of high voltage wires, and the respective wires are secured to the securing body in a bundled state.

[0030] According to this structure, since the high voltage wires are bundled, the rigidity thereof increases compared to a case in which the respective high voltage wires are secured separately. As a result, the high voltage wires are less likely to vibrate, and thus interference with other parts can further be suppressed.

[0031] According to the invention according to claim 12, in the invention according to any one of claims 2 to 11, securing means for securing the high voltage wire to the securing body is provided integrally with the securing body.

[0032] According to this structure, since the securing means is provided integrally with the securing body, the number of parts can be reduced compared to a case in which these are provided separately.

[0033]

[EMBODIMENTS OF THE INVENTION]

Hereafter, with reference to FIGS. 1 to 4, a description will be given of an embodiment in which the invention is applied to a hybrid vehicle that has a front-engine rear-drive (FR) type drive system in which an engine is mounted in the front portion of the vehicle and drives the rear wheels.

[0034] A hybrid vehicle 10 according to the present embodiment is provided with two types of driving sources for running, namely, an engine 11 and an electric motor, which have different characteristics, and runs by optimally combining driving force according to conditions and transmitting it to driving wheels. It should be noted that, in FIG. 1, the left side indicates a front side in a longitudinal direction of the hybrid vehicle 10, while the right side indicates a rear side in the longitudinal direction of the hybrid vehicle 10.

[0035] The engine 11 is disposed in front of a dash panel 14 which is a partition between an engine room (also referred to as an engine compartment) 12 and a cabin 13 of the hybrid vehicle 10. The present embodiment employs, as the engine 11, a V-type engine in which a pair of banks 15 each having a plurality of cylinders (cylinders 16) is disposed in the form of a V-shape. The engine 11 is mounted in the engine room 12 such that the cylinders 16 of each bank 15 are lined up in the vehicle longitudinal direction (refer to FIG. 2). As an engine accessory 18, an intake pipe 19 for introducing air into each cylinder 16 is fixed to the engine 11. In addition, a surge tank, various accessories (such as an alternator and a water pump) are fixed to the engine 11 as the engine accessories 18.

[0036] In the engine 11, exhaust pipes 23 (refer to FIG. 3) for guiding exhaust gas generated by operation of the engine 11 to outside of the engine are provided for respective cylinders 16. The exhaust pipes 23 extend toward the outer sides of the vehicle from the corresponding banks 15. The plurality of exhaust pipes 23 provided for each bank 15 are joined together into one.

[0037] A transmission 20 is disposed in back of the engine 11 with respect to the vehicle longitudinal direction in a state adjacent to the engine 11. The transmission 20 is connected to and driven by an output shaft of the engine 11. At least a part of the transmission 20 is positioned within a center floor tunnel 22 provided in the floor of the hybrid vehicle 10. Furthermore, portions of the exhaust pipes 23 provided for the banks 15 mentioned above are disposed in opposing locations that sandwich the transmission 20, as shown in FIG. 3.

[0038] Two motor-generators MG1 and MG2 are incorporated within the transmission 20 as electric motors. The motor-generators MG1 and MG2 are constructed of alternating-current synchronous motors. These motors function as generators in addition to functioning as motors, and are also capable of switching such functions depending on conditions. For example, the MG1 mainly serves as a generator for generating electricity by power of the engine 11 during normal running of the hybrid vehicle 10. Also, the MG2 mainly serves as a motor that generates auxiliary power for driving the driving wheels separately from the power of the engine 11. It should be noted that the transmission 20 incorporates, in addition to the MG1 and MG2, a power split mechanism for distributing power generated by the engine 11 to the MG1 and the driving wheels, a deceleration mechanism, and the like.

[0039] Meanwhile, an inverter 24 is installed near and above the engine 11 in a vehicle body 17 (refer to FIG. 4). This inverter 24 is connected to a battery (not shown) by a high voltage wire. Furthermore, as shown in FIGS. 1 and 2, the inverter 24 is connected to the MG1 by a plurality of (for instance, three) high voltage wires 25 routed through a space between the engine 11 and the dash panel 14. Similarly, the inverter 24 is connected to the MG2 by a plurality of (for instance, three) high voltage wires 32 routed through a space between the engine 11 and the dash panel 14. The inverter 24 converts direct current from the battery into alternating current to supply the MG1 and MG2, and converts alternating current generated by the MG1 into direct current to charge the battery.

[0040] As shown in FIGS. 1 and 3, an opening 26 is provided at a point slightly offset toward a lateral side of the vehicle from a top portion (the highest point) 21 in a front portion of the transmission 20. A wire pull-out portion 27 is attached here. The bottom portion of the wire pull-out portion 27 positioned within the transmission 20 is provided with connecting terminals (not shown) of the same number as there are stator coils of the MG1, and these connecting terminals are connected to the corresponding stator coils. Furthermore, the wire pull-out portion 27 is electrically connected to the plurality of high voltage wires 25. These high voltage wires 25 are gathered into one by being placed within a common tube 28. The tube 28 extends from the wire pull-out portion 27 substantially upward in the vicinity of the engine 11, and is bent toward a lateral side of the vehicle (the inverter 24 side) in the middle. The bent portion extends in a substantially horizontal direction in the

vicinity of the intake pipe 19. Each of the high voltage wires 25 within the tube 28 is electrically connected to the inverter 24.

[0041] Similarly, another opening 29 is provided, in the front portion of the transmission 20, on the opposite side from the opening 26 in a manner so as to sandwich the top portion 21. A wire pull-out portion 31 is attached here. The bottom portion of the wire pull-out portion 31 positioned within the transmission 20 is provided with connecting terminals (not shown) of the same number as there are stator coils of the MG2, and these connecting terminals are connected to the corresponding stator coils. Furthermore, the wire pull-out portion 31 is electrically connected to the plurality of high voltage wires 32 (refer to FIG. 2). These high voltage wires 32 are gathered into one by being placed within a common tube 33. The tube 33 extends from the wire pull-out portion 31 substantially upward in the vicinity of the engine 11, and is bent toward a lateral side of the vehicle (the inverter 24 side) in the middle. The bent portion extends in a substantially horizontal direction in the vicinity of the intake pipe 19. The tube 33 overlaps the tube 28 at a part of the portion thereof that extends in the horizontal direction. Each of the high voltage wires 32 within the tube 33 is electrically connected with the inverter 24.

[0042] Meanwhile, both of the high voltage wires 25 and 32 are secured, at middle portions thereof, to a securing body by securing means. The securing body consists of at least one of the engine 11, the engine accessory 18, and the transmission 20. Here, the engine 11 and the intake pipe 19 serve as the securing bodies. Also, the securing means is constructed of clamps 34, 35, and 36 that are attached to the engine 11 and the intake pipe 19 by fastening means such as bolts. The tubes 28 and 33 are secured by these clamps 34 to 36. More specifically, the portions of the tubes 28 and 33 that extend substantially upward from the wire pull-out portions 27 and 31 are each secured to a rear face of the engine 11 by the clamp 34. Furthermore, the portion of the tube 33 that extends in the substantially horizontal direction is secured to a rear face of the intake pipe 19 by two clamps 35 and 36. Moreover, the portion of the tube 28 that extends in the substantially horizontal direction is secured to the rear face of the intake pipe 19 by the clamp 36. That is, the overlapping portions of the tubes 28 and 33 are secured to the intake pipe 19 by the common clamp 36.

[0043] It should be noted that the clamps 34 to 36 may employ a known structure such one in which, for example, the tubes 28 and 33 are elastically secured by a grooved holding portion, a part of which is open. In addition, the clamps 34 to

36 may employ a structure that is provided with a pair of holding portions coupled via a hinge so as to be capable of opening and closing, and a securing portion for securing both holding portions in a closed state. In the latter type, the tubes 28 and 33 are surrounded by both holding portions, and the tubes 28 and 33 are held by securing both holding portions with the securing portion.

[0044] As shown in FIG. 4, the high voltage wires 25 and 32 within the tubes 28 and 33 can be divided into a restricted portion 37 which is secured, by the clamps 34 to 36, to a securing body such as the engine 11, the intake pipe 19, and the like so that the movement thereof is restricted, and a non-restricted portion 38 which is not secured to a securing body so that the movement thereof is not restricted. Specifically, with regard to the high voltage wire 25 within the tube 28, generally, between the wire pull-out portion 27 and the clamp 36 corresponds to the restricted portion 37, and between the clamp 36 and the inverter 24 corresponds to the non-restricted portion 38. Furthermore, with regard to the high voltage wire 32 within the tube 33, generally, between the wire pull-out portion 31 and the clamp 36 corresponds to the restricted portion 37, and between the clamp 36 and the inverter 24 corresponds to the non-restricted portion 38.

[0045] It should be noted that relative movement occurs between the inverter 24 and the engine 11, the transmission 20, and the like during operation of the engine 11. Therefore, the high voltage wires 25 and 32 that connect the inverter 24 with the MG1 and MG2 must absorb this relative movement. In this case, since the movement of the restricted portions 37 of the high voltage wires 25 and 32 is restricted, the aforementioned requirement can not be satisfied by these portions. To the contrary, the movement of the non-restricted portion 38 is not restricted, allowing deformation thereof to some extent. Accordingly, a length of the non-restricted portion 38 is set with some allowance so as to be able to absorb the relative movement described above.

[0046] According to the present embodiment that employs the structure described above, the engine 11 vibrates in an output-shaft rotational direction, a longitudinal direction, a vertical direction, and the like. Also, the transmission 20 itself also vibrates by its own operation. These vibrations are transmitted to the engine accessory 18, and also to both high voltage wires 25 and 32 through the wire pull-out portions 27 and 31 attached to the transmission 20.

[0047] In this case, it is conceivable to secure the high voltage wires 25 and 32 to the vehicle body 17 in order to suppress the high voltage wires 25 and 32 from vibrating. For instance, since the high voltage wires 25 and 32 are positioned in front of the dash panel 14, it is also conceivable to use the dash panel 14 and secure the high voltage wires 25 and 32 thereto. However, in this case, vibrations of the engine 11 and the transmission 20 are transmitted to the dash panel 14 through the high voltage wires 25 and 32. Such transmission may cause vibrations and generate abnormal noise in the dash panel 14.

[0048] In contrast, the high voltage wires 25 and 32 are not secured to the vehicle body 17 in the present embodiment. Therefore, vibrations of the engine 11 and the transmission 20 are less likely to be transmitted to the vehicle body 17 through the high voltage wires 25 and 32.

[0049] Furthermore, according to the present embodiment, portions of respective high voltage wires 25 and 32 that are on the engine 11 side are designed as the restricted portions 37, and are secured to the engine 11 and the intake pipe 19 by the clamps 34 to 36. As a result, the movement of the restricted portions 37 is restricted at the points that are secured to the engine 11 and the intake pipe 19, and therearound. Combined with the increased rigidity by the plurality of the high voltage wires 25 and 32 being gathered together and placed in the common tubes 28 and 33, both restricted portions 37 are less likely to move with respect to the engine 11 and the transmission 20.

[0050] Furthermore, if the middle portion of the high voltage wires 25 and 32 were not secured at all, the high voltage wires 25 and 32 would move with respect to the connecting portion with the MG1 and MG2 (the wire pull-out portions 27 and 31) due to vibration of the engine 11 and the like, and a load would thus be applied to the wire pull-out portions 27 and 31. This load may become one of the causes of wire disconnection and the like.

[0051] To the contrary, according to the present embodiment, the aforementioned restriction suppresses movement of both restricted portions 37 with respect to the MG1 and MG2. Consequently, a load applied to the connecting portions of both of the high voltage wires 25 and 32 with the MG1 and MG2 (the wire pull-out portions 27 and 31) can be reduced.

[0052] Meanwhile, the inverter 24 is fixed to the vehicle body 17 separately from the engine 11 and the like, and thus does not vibrate by itself.

Accordingly, relative movement is caused between the inverter 24 and the MG1 and MG2. In contrast, the portions (the non-restricted portions 38) of the high voltage wires 25 and 32 that are on the inverter 24 side are not secured to the engine 11 and the like, allowing deformation thereof to some extent. The aforementioned relative movement is absorbed by deformation of the non-restricted portions 38.

[0053] Meanwhile, both exhaust pipes 23 through which exhaust gas generated by the operation of the engine 11 flows are subject to heat. In the V-type engine, these exhaust pipes 23 are positioned toward the lateral sides of the vehicle from the respective banks 15. In contrast, the high voltage wires 25 and 32 are routed behind the engine 11 and near and above the transmission 20. Accordingly, since the high voltage wires 25 and 32 are positioned relatively far apart from the exhaust pipes 23, the high voltage wires 25 and 32 are not susceptible to the effects of heat radiated from the exhaust pipes 23. Moreover, the restricted portions 37 of the high voltage wires 25 and 32 are secured to the intake pipe 19, which is a point where the temperature is the lowest among the securing bodies (the engine 11, the engine accessory 18, and the transmission 20). Therefore, the effect of heat from the engine 11 and the like on the high voltage wires 25 and 32 is less compared to a case in which the high voltage wires 25 and 32 are secured to another securing body.

[0054] Furthermore, when impact is applied to the hybrid vehicle 10, devices, parts, and the like arranged around the engine 11 are normally more likely to be deformed or displaced than the engine 11 is. Therefore, for instance, when the impact is applied to the hybrid vehicle 10 from the front, the devices, parts, and the like arranged in front of the engine 11 are deformed or displaced to the rear, thereby reducing the clearance between them and the engine 11. Similarly, for example, when the impact is applied to the hybrid vehicle from the side, the devices, parts, and the like arranged to the vehicle lateral side of the engine 11 are deformed or displaced, thus reducing the clearance between them and the engine 11.

[0055] Accordingly, if the high voltage wires 25 and 32 are routed in front of the engine 11 with respect to the vehicle longitudinal direction, when the impact is applied to the hybrid vehicle 10 from the front, the high voltage wires 25 and 32 are pinched between the engine 11 and the devices, parts, and the like arranged in front of the high voltage wires 25 and 32. Furthermore, if the high voltage wires 25 and 32 are routed to a side of the engine 11, when the impact is applied to the hybrid vehicle 10 from the side, the high voltage wires 25 and 32 are pinched between the engine 11

and the devices, parts, and the like arranged to the side of the high voltage wires 25 and 32. Such pinching may cause the high voltage wires 25 and 32 to break or disconnect.

[0056] In regard to this point, in the present embodiment in which the high voltage wires 25 and 32 are routed behind the engine 11 with respect to the vehicle longitudinal direction, the engine 11 is not susceptible to deformation or displacement even if impact is applied to the hybrid vehicle 10 from the front. Accordingly, the high voltage wires 25 and 32 are less likely to be pinched between the engine 11 and the devices, parts, and the like arranged behind the high voltage wires 25 and 32. Similarly, the high voltage wires 25 and 32 are less likely to be pinched between the engine 11 and the devices, parts, and the like arranged to the side of the high voltage wires 25 and 32.

[0057] Furthermore, when the impact is applied from the front, the high voltage wires 25 and 32 are protected by the robust engine 11. Even if the engine 11 were displaced to the rear by the impact, that impact would be absorbed by a reinforcement and the like and reduced. In addition, the dash panel 14 behind the high voltage wires 25 and 32 has relatively low rigidity. Therefore, when the impact is applied to the dash panel 14 through the engine 11, the dash panel 14 deforms. Consequently, even if the high voltage wires 25 and 32 are pinched between the engine 11 and the dash panel 14, force applied to the high voltage wires 25 and 32 is small.

[0058] According to the present embodiment described above, the following effects can be obtained.

(1) The high voltage wires 25 and 32 connecting the inverter 24 and the MG1 and MG2 are routed behind the engine 11 with respect to the vehicle longitudinal direction. Therefore, even if impact is applied from the side or impact is applied from the front to the hybrid vehicle 10, disconnection or breakage of the high voltage wires 25 and 32 can be suppressed.

[0059] (2) The engine 11 and the intake pipe 19 serve as the securing bodies and the middle portions (the restricted portions 37) of the high voltage wires 25 and 32 are secured to these securing bodies. Therefore, unlike a case in which the high voltage wires 25 and 32 are secured to the points that have relatively low rigidity even in the vehicle body 17, for instance, the dash panel 14 and the like, vibration of the engine 11 and the transmission 20 is less likely to be transmitted to the dash panel

14 and the like through the high voltage wires 25 and 32, thus suppressing unnecessary vibration and noise.

[0060] (3) In (2) above, in order to eliminate a problem (transmission of vibration from the engine 11 and the like to the dash panel 14 and the like) caused by securing the high voltage wires 25 and 32 to the dash panel 14 and the like, the high voltage wires 25 and 32 may be secured to a point that is resistant to vibration (that is, a point not susceptible to vibration) such as a reinforcement and a side member. Such an arrangement would enable vibration of the vehicle body 17 to be suppressed. However, since these members are placed apart from the engine 11, the high voltage wires 25 and 32 would need to be long so that they could be secured there.

[0061] In this regard, since the present embodiment enables suppression of transmission of vibration to the vehicle body 17 as described above, the high voltage wires 25 and 32 need not to be secured to the aforementioned reinforcement and the side member. Accordingly, the aforementioned problem (that a long high voltage wire is required) caused by securing the wires to the reinforcement and the like is less likely to occur.

[0062] (4) In addition to (3) above, according to the present embodiment, the inverter 24 is positioned near and above the engine 11, and the connecting points between the MG1 and MG2 and the high voltage wires 25 and 32 are set at the upper portion of the transmission 20. The high voltage wires 25 and 32 are arranged behind the engine 11 and near and above the transmission 20. Therefore, the MG1 and MG2 can be connected to the inverter 24 by the high voltage wires 25 and 32 by a substantially shortest route. Since the high voltage wires 25 and 32 can be made short, the material cost and the weight can also be reduced.

[0063] (5) The high voltage wires 25 and 32 comprise the restricted portion 37 that is secured to the securing body whereby the movement thereof is restricted, and the non-restricted portion 38 that is not secured to the securing body so that the movement thereof is not restricted. The high voltage wires 25 and 32 are routed such that the restricted portion 37 is positioned to the engine 11 and transmission 20 side, and the non-restricted portion 38 is positioned to the inverter 24 side.

[0064] As a result, interference between the restricted portion 37 and other parts due to vibration of the restricted portion 37 with respect to the engine 11 and the transmission 20 can be suppressed. Accordingly, clearance between the high voltage

wires 25 and 32 and other parts can be made small, enabling the space for routing the high voltage wires 25 and 32 to be reduced.

[0065] Furthermore, the movement of the high voltage wires 25 and 32 with respect to the MG1 and MG2 is suppressed, thereby enabling the load applied to the wire pull-out portions 27 and 31 to be reduced. Therefore, when the applied load is large, the wire pull-out portions 27 and 31 must be made robust so as to be able to withstand the load, which may result in the shape or structure of the wire pull-out portions 27 and 31 becoming complicated. However, there is no such concern with the present embodiment. That is, the shape or structure of the wire pull-out portions 27 and 31 can be simplified, and the size of the wire pull-out portions 27 and 31 can be reduced.

[0066] Moreover, the relative movement between the engine 11 and the transmission 20, and the inverter 24 can be absorbed by the non-restricted portion 38. This effect can also be obtained when the inverter 24 is positioned relatively far away from the MG1 and MG2. Therefore, the wire pull-out portions 27 and 31 on the MG1 and MG2 side can be positioned away from a wire pull-out portion on the inverter 24 side, and thus an effect in which the degree of freedom in design with regard to mountability is increased can also be obtained.

[0067] (6) A plurality of high voltage wires 25 and 32 are connected to each MG1 and MG2, and these high voltage wires 25 and 32 are placed together in the common tubes 28 and 33. As a result, the rigidity increases compared to a case in which each of the high voltage wires 25 and 32 is restricted separately. This is effective in suppressing vibration of the restricted portions 37.

[0068] (7) The high voltage wires 25 and 32 are secured to the intake pipe 19 which is considered to have the lowest temperature from among the securing bodies. Consequently, the effect of heat on the high voltage wires 25 and 32 from the engine 11, the transmission 20, and the like can be reduced.

[0069] (8) The high voltage wires 25 and 32 routed behind the engine 11 are distanced from the exhaust pipes 23 that are disposed toward the vehicle lateral sides when viewed from the engine 11. In the present embodiment, the high voltage wires 25 and 32 are secured to the intake pipe 19 or the upper rear face of the engine 11 at a point away from the exhaust pipes 23. Thus, the effect of heat from the exhaust pipe 23 on the high voltage wires 25 and 32 can be suppressed.

[0070] Particularly, in the present embodiment that employs the V-type engine, the high voltage wires 25 and 32 are positioned near and above the transmission 20 as described above, whereby the high voltage wires 25 and 32 are away from the exhaust pipes 23. This arrangement is therefore effective for suppressing the effect of heat from the exhaust pipes 23.

[0071] As a result, a low heat resistant material can be used for the high voltage wires 25 and 32, thereby enabling costs to be reduced. Moreover, there is no need to take a measure such as providing a heat shield for suppressing the effect of the heat from the exhaust pipes 23.

[0072] It should be noted that the invention can be embodied in another embodiment described below.

· As shown in FIG. 5, if a soundproof cover 39 is attached to the engine 11 as the engine accessory 18, the soundproof cover 39 may be provided integrally with securing means (such as a clamp 40), and the high voltage wires 25, 32 may be secured to the engine 11 through the soundproof cover 39 having this clamp 40. If this structure is employed, the number of parts can be reduced compared to a case in which the soundproof cover 39 and the securing means are provided separately to secure the high voltage wires 25, 32. It should be noted that the soundproof cover 39 is for insulating noise vibration radiated from the engine 11, and is composed of, for example, a shielding plate 39a attached to the engine 11, and a sheet of sound absorbing material 39b that is attached to the inner side (the engine 11 side) of the shielding plate 39a and is made of glass wool, urethane foam, or the like.

[0073] In this case, a plurality of high voltage wires 25, 32 are secured to the soundproof cover 39 in a bundled state. Therefore, the rigidity increases compared to a case in which each of the high voltage wires 25, 32 is secured separately. As a result, vibration of the high voltage wires 25, 32 is less likely to occur, thereby enabling interference with other parts to be suppressed.

[0074] · As shown by the two-dotted chain line in FIG. 1, when a transmission accessory 41 is fixed to the transmission 20, the transmission accessory 41 may serve as one of the securing bodies, and the middle portions of the high voltage wires 25 and 32 may be secured thereto. The transmission accessory 41 may be an accessory such as an oil pump and the like.

[0075] · The securing body to which the high voltage wires 25 and 32 are secured may simply be at least one of the engine 11, the engine accessory 18, the

transmission 20, and the transmission accessory 41. For example, since the structure according to the present embodiment is such that the wire pull-out portions 27 and 31 are attached to the front portion of the transmission 20, both high voltage wires 25 and 32 are secured to the engine 11 and the engine accessory (the intake pipe 19). However, when the wire pull-out portions 27 and 31 are fixed to the rear portion or the middle portion in the longitudinal direction of the transmission 20, it is preferable that the high voltage wires 25 and 32 also be secured to the transmission 20 and the transmission accessory 41.

[0076] · The invention can also be applied to an in-line engine in addition to the V-type engine.

· The invention can also be applied to a hybrid vehicle that employs a front-engine front-drive (FF) type drive system in which the engine is mounted in the front portion of the vehicle and drives the front wheels. In this case, a transmission is disposed adjacent and to a vehicle lateral side when viewed from the engine, however, the high voltage wires are routed behind the engine with respect to the vehicle longitudinal direction in a fashion similar to that described above.

[0077] · The transmission may incorporate one electric motor (motor-generator) therein.

·The attaching positions of the wire pull-out portions 27 and 31 with respect to the transmission 20 may be changed to a point that is different from those in the aforementioned embodiments, for example, the top portion 21 of the transmission 20 as shown in FIGS. 3 and 4. Such a change is possible when a single aforementioned motor-generator is used.

[0078] · The high voltage wires 25 and 32 may also be secured to the vehicle body 17, for instance, the dash panel 14. Furthermore, the invention may also be applied to another type of a hybrid vehicle in which the inverter is fixed to the engine instead of to the vehicle body. Even if such a structure is employed, as long as the requirement that "the high voltage wires be routed behind the engine with respect to the vehicle longitudinal direction" is satisfied, the object of the invention to suppress breakage or disconnection of the high voltage wires due to impact can be achieved.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

FIG. 1 is a partial side view of a high voltage wire routing structure according to an embodiment of the invention.

[FIG. 2]

FIG. 2 is a partial plan view of the routing structure.

[FIG. 3]

FIG. 3 is a partial front view of a transmission and the routing structure.

[FIG. 4]

FIG. 4 is a schematic drawing showing the positional relationship of the transmission, an inverter, a high voltage wire, and the like.

[FIG. 5]

FIG. 5 is a partial perspective view showing another embodiment in which a high voltage wire is secured to an engine via a soundproof cover having a clamp.

[DESCRIPTION OF THE REFERENCE NUMERALS]

10...HYBRID VEHICLE

11...ENGINE

12...ENGINE ROOM

15...BANK

16...CYLINDER

17...VEHICLE BODY

18...ENGINE ACCESSORY

19...INTAKE PIPE

20...TRANSMISSION

23...EXHAUST PIPE

24...INVERTER

25, 32...HIGH VOLTAGE WIRE

34-36, 40...CLAMP (SECURING MEANS)

37...RESTRICTED PORTION

38...NON-RESTRICTED PORTION

41...TRANSMISSION ACCESSORY

MG1, MG2...MOTOR-GENERATOR (ELECTRIC MOTOR)

[Name of the Document] Abstract of the disclosure

[ABSTRACT]

[TASK] To provide a high voltage wire routing structure of a hybrid vehicle by which breakage or disconnection of a high voltage wire can be suppressed even if impact is applied to the hybrid vehicle.

[MEANS OF SOLVING THE PROBLEM]

A hybrid vehicle 10 to which this routing structure is applied includes, as driving sources for running, an engine 11 and a motor-generator (MG1, MG2) as an electric motor. Also in the hybrid vehicle 10, the engine 11 and an inverter 24 are mounted in an engine room 12, and a transmission 20 which incorporates the MG1, MG2 is disposed adjacent to the engine 11. In this routing structure, a high voltage wire 25 which connects the inverter 24 with the MG1 (MG2) is routed behind (to the right in the drawing) the engine 11 with respect to a vehicle longitudinal direction.

[SELECTED DRAWING] FIG. 1

[NAME OF THE DOCUMENT] Drawings

[FIG. 1]

11/ENGINE

12/ENGINE ROOM

18/ENGINE ACCESSORY

19/INTAKE PIPE

20/TRANSMISSION

24/INVERTER

25/HIGH VOLTAGE WIRE

34, 36/CLAMP

MG1, MG2/MOTOR-GENERATOR

[FIG. 2]

1/INTAKE AIR